TRANSACTIONS

OF THE

Philosophical Institute of Victoria.

Art. I.—*On a New Form of Propeller for Steam Ships.* By David E. Wilkie, M.D.

[Read before the Institute, 4th February, 1857.

Not more than forty years have elapsed since steam power was first successfully applied to the propulsion of ships by means of paddle wheels, and, ever since that time, paddle wheels, with a few modifications in their construction, have continued to maintain their ground, notwithstanding the numerous inventions that have been proposed as a substitute. The most important of these inventions is the screw, which was successfully brought into use in 1836 through the exertions of Capt. Ericcson and Mr. J. P. Smith.

With the experiènce of twenty years the screw has undergone several important improvements,—the most practically valuable of which appears to be that of Mr. Robert Griffiths, which furnishes a simple means of altering the pitch of the blades, according to the velocity and the resistance. This new form of screw has also the advantage of acting equally well reversely, so that, in this respect, the screw and the paddle wheels are very nearly equal.

I shall not occupy your time with discussing the advantages and disadvantages of these two methods of propulsion; but it is necessary to state, shortly, the facts that have been ascertained respecting their efficiency, and the reasons that have led scientific men to devote their attention to the discovery of some new and better method of propulsion.

The paddle wheels act on the surface of the water where there is least resistance, and are liable to great irregularity of action in a rough sea. There is, in consequence, a considerable slip, or loss of velocity. The oblique action of the floats on the water also involves a loss of power.

The indirect transmission of power from the piston to the paddle wheels through a ponderous crank engine involves an additional loss of power.

The paddle wheels also act to great disadvantage when the vessel is either too heavily, or too lightly freighted.

It has been estimated in a recent article in the *New York Commercial Gazette* that of the actual motive-power of the Collins steamers, not more than one-half is available in their speed.

The screw also has many serious defects, and notwithstanding the great efforts that have been made to remove them it has hitherto proved inferior to the paddle wheels, especially when great velocity is required, or when there is great resistance to be overcome—as in head winds; and it has, therefore, been chiefly used as an auxiliary in full-rigged ships and men-of-war.

The screw has the advantage of working in deep water, where there is increased resistance; but its oblique action on the water is its great source of weakness, and is one of those difficulties which cannot by any possible means be remedied.

If we look to Nature as our guide, and take the feet of swimming birds, and the fins of fishes, as our model, we shall see that a perfect propeller should act wholly under water, as the screw, but, unlike the screw, the blades, or floats, of the propeller should act at right angles to the water.

The problem to be solved, therefore, is to discover some simple and effectual means of feathering the floats of a propeller under water without loss of power, and of reversing their action when backward motion is required.

Here it will, perhaps, be impossible in every respect to imitate the natural propellers of swimming birds and fishes, and especially that power which they possess of lessening the surface and resistance of their propellers in the act of feathering them; but let the attempt, at least, be made to imitate this natural action as far as possible, and if it should be found that there is necessarily some loss of power in feathering the floats, under the most favourable conditions, this will at least admit of being greatly diminished by lengthening the stroke, and thus diminishing the frequency of the feathering. A perfect propeller should also admit of being connected directly to the piston-rod of the steam cylinder, so as to avoid the loss of power necessarily resulting from a heavy crank engine.

This simple arrangement, however, would necessarily depend on a much greater speed of piston than that already attained.

A perfect propeller should also, when in action, have very little slip in the water, and when not in use it should either be capable of being readily lifted out of the water, or it should offer no impediment to the motion of the ship under canvas. Such are the necessary conditions, as it appears to me, that we are to look for in any form of propeller that is likely to offer superior advantages to the paddle wheels and screw.

These conditions, I think, will be readily admitted to be theoretically essential, although it may be alleged that the inventive genius of scientific men has already been taxed to the utmost to discover such a form of propeller without success.

But are we, on this account, to despair of all further improvement in our modes of propulsion? If it is true that one-half, or a larger per centage, of the steam power in marine engines is lost, or unavailable, in its application to the paddle wheels, and that the screw for purposes of speed is in no respect superior to the paddle wheels, is it at all likely, with these means of propulsion, that we shall ever obtain a velocity commensurate with the requirements of modern civilization?

Can we allow ourselves to believe that there is the same lavish waste of power in the mechanism which Nature has provided for the rapid movement of aquatic birds and fishes in their native element?

Past experience would seem to show that the larger the vessel the less is the proportionate resistance with the same lines and proportion of beam, and the greater the velocity with the same proportion of propelling power.

Unless, therefore, we are prepared to maintain that the propelling power in fishes is much greater, in proportion to their size, than is required in steam ships to obtain the same velocity, it is correct to infer that the propelling fins of fishes act much more effectively, and with less loss of power, than the paddle wheels and screw.

If, therefore, we assume that there is no such loss of power in Nature's machinery, surely we shall admit that by imitating Nature more closely than we have hitherto done we may yet succeed in discovering a mode of propulsion of greater power, and of more simple application, than the existing modes.

I cannot but hope that there is a wide field yet open for improvement in marine propulsion, and that modern science will yet develop more simple and effective means of obtaining a greatly increased velocity in steam navigation.

In accomplishing this desirable end, much remains to be done in improving the form and construction of ships themselves, and in thus lessening their resistance to the water; but it is no less true that a great increase of velocity would result from an improved mode of propulsion, by which the present waste of steam power would be avoided, and by which the whole power employed would be rendered effective for direct propulsion.

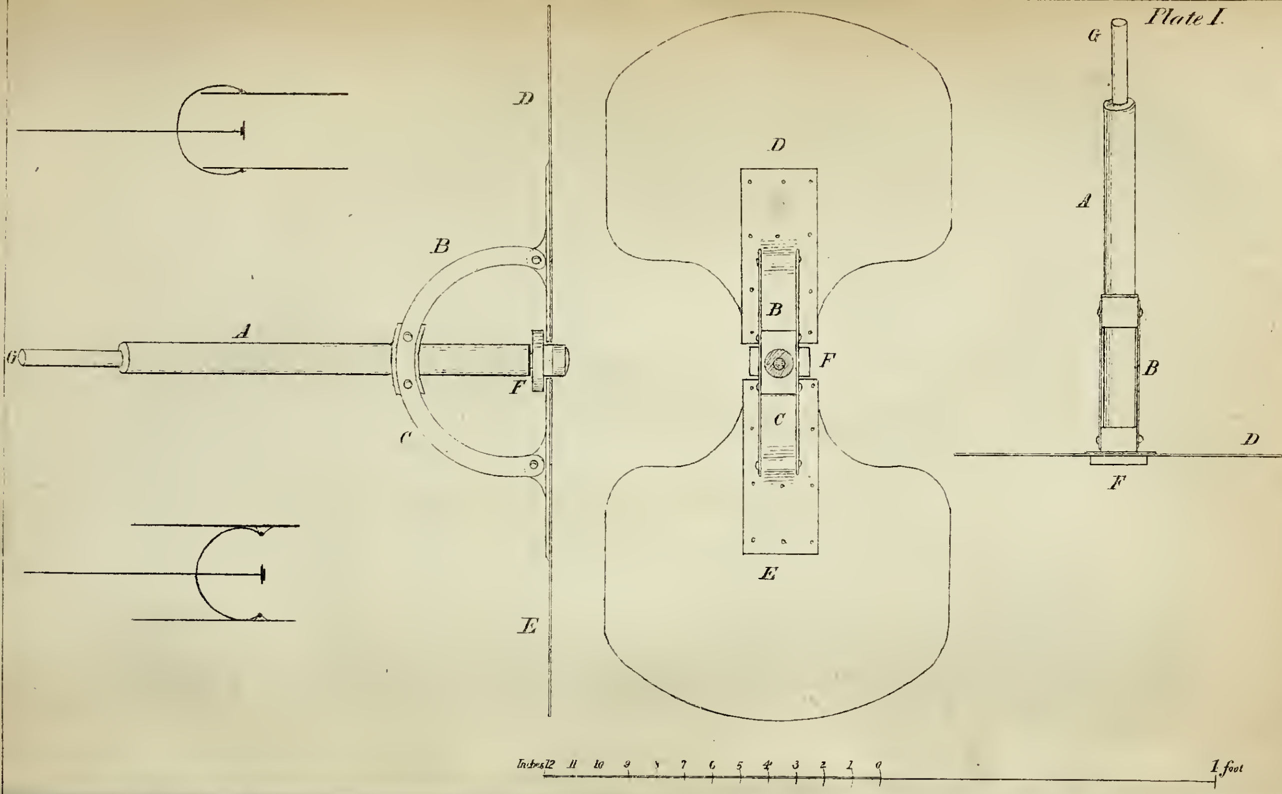
It had long occurred to me that some more effective mechanism than the paddle wheels or screw might yet be discovered; but it was only a few months since that I accidentally directed my attention to the subject, and it is with some diffidence that I now venture to bring under the notice of the Institute the model of a propeller upon a new principle, and whose object is to fulfil, as far as possible, the conditions which I have specified.

If the principle of its action is correct, and if it shall be found to possess any advantages over the paddle wheels, or the screw, I shall be glad to think that I have contributed to the advancement of practical science.

If, on the other hand, it shall be found to be unavailable, or inferior to other existing modes of propulsion, I shall, at all events, not regret that I have devoted some attention to a subject so interesting in a scientific point of view, and so important to the future commerce of the world.

The construction of this propeller is very simple, and easily understood, and, whatever may be the result of its practical application, I am not without hope that, in the principle of its action, you will find that it approaches very nearly to the conditions which were stated theoretically to belong to a perfect propeller.

Plate I.



Description of the Propeller (see plate).—The propeller consists of a shaft, *A*, with two arms, *B, C*, and two floats, *D, E*. The shaft is hollow, and, in the model, consists of an iron tube of one inch diameter, and five feet long; the two arms are fixed on the shaft near its extremity, in the form of a semicircle, with the concavity outwards, and they terminate three inches from the shaft, in a hinge point, to which the floats are attached. The floats consist of thin sheet iron, and are of an oblong shape, being 9 inches in length, and 12 inches in breadth. They are rounded or semicircular at the extreme end, and more rectangular at the opposite end, where they are hinged to the arms. From the hinge to the shaft there is a narrow projecting part, which rests on the shoulder *F* when the propeller is in action. From the construction of the joint the floats have an extensive motion, permitting them to feather either for forward or backward motion. The shoulder *F* is of brass, and being double, presents the form of a cross, and is fitted into the extremity of the shaft by a screw, at the same time this brass shoulder is connected to a smaller iron tube inside the shaft. This arrangement is for the purpose of turning the brass shoulder, and this is effected by means of the handle *G*, at the opposite end of the shaft, where there is also a stop, by which its motion is limited to a quarter of a circle. The shoulder in one position secures the floats for forward motion, and in the other position for backward motion. In forward motion, if the shoulder is turned while the floats are resting on it, their action becomes reversed in the return stroke, and in the same way in backward motion, if the shoulder is turned while the floats are resting on it, the backward motion becomes changed to forward motion.

To obtain uniformity of motion it will, under any circumstances, be necessary to have two propellers.

In large vessels it is proposed that the shafts of the propellers should work in the dead wood in front of the sternpost, and that the dead wood should be extended to the length of the stroke of the propellers, two horizontal spaces, *E* and *F*, being prepared for their reception, and provided with guides above and below, the floats, on either side of the dead wood, working free of the ship.

The shafts being thus secured, it is considered that the propellers will be very little liable to be affected by heavy seas, probably much less than the paddles or screw.

The propellers may be worked by two levers, and either one or two cylinders, as represented in Plate II.

Length of stroke being essential for speed the levers must be proportionably long, but it is also necessary to multiply the speed of the piston by attaching the connecting-rod to the levers proportionably near to the fulcrum.

a b and *c d* represent the levers, *a* and *c* being the fulcra on which they move. The lever *a b* is extended to *i* for the purpose of connecting the action of the two cylinders, and concentrating the power of both cylinders upon each propeller alternately, by means of the connecting-rod *i k*. *g* and *h* represent the cylinders, and *d e* and *b f* the propellers.

For the purpose of reversing the action of the propellers a moveable inclined plane will be fixed at each end of the stroke of the shaft within the ship, and when it is required to reverse the action the inclined plane will be placed in position to raise the projecting lever attached to the inner tube of the shaft. The rotation of the shoulder will thus be rapidly effected at the proper time without stopping the piston.

The first requirement in steam propulsion is speed, and at first sight the propeller which I have just described may seem only suited for low rates of velocity.

In low-pressure marine engines the speed of the piston averages about 250 feet per minute. Any required speed in the propeller, however, could be obtained by means of levers, as shown above.

But to obtain very high rates of speed with this propeller, or indeed with any other method of propulsion, it will be necessary to adopt high-pressure steam in marine engines.

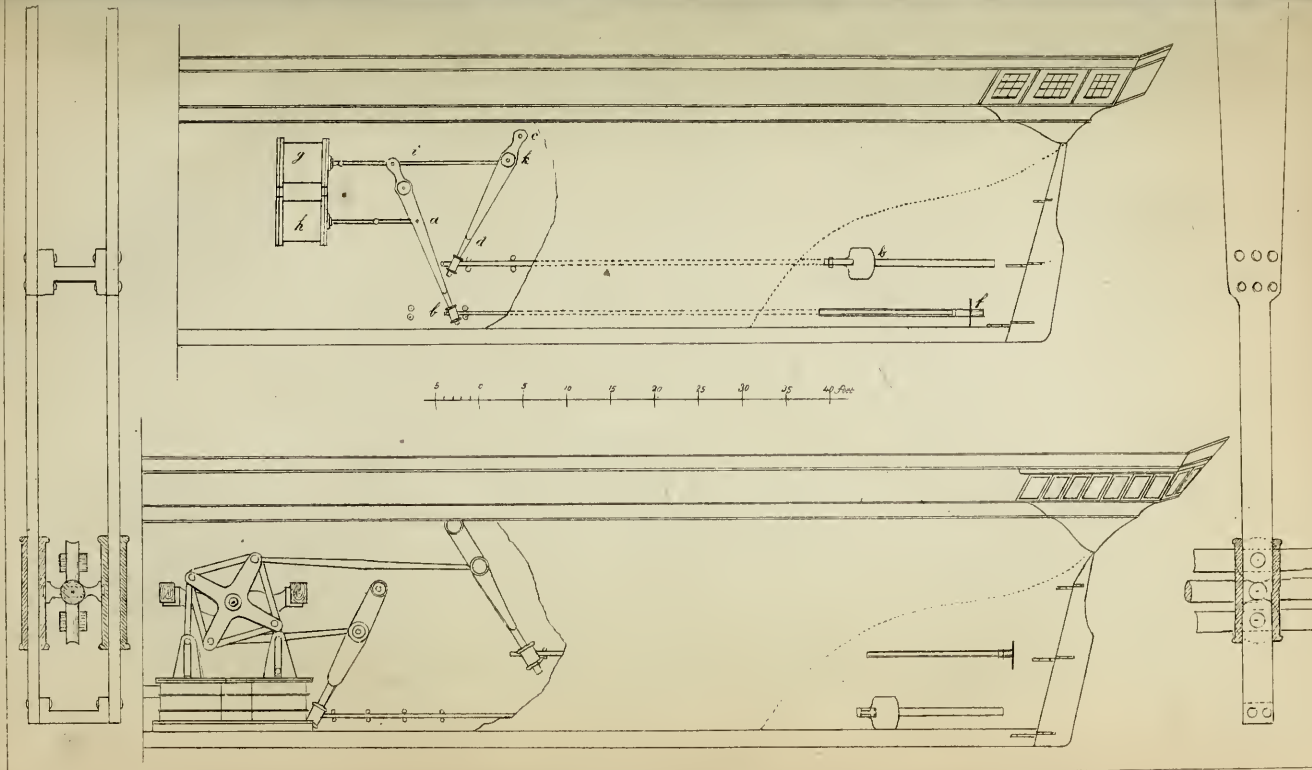
Hitherto steam vessels have been built, not exclusively for speed, but rather with the view of combining speed with carrying power.

For the purposes of modern mail communication speed ought to be almost exclusively aimed at, and when ships are built on this principle it will be necessary to abandon the ponderous low-pressure or condensing engines, and to adopt light high-pressure engines, similar in principle to those found so effective in locomotives on railways.

The greater speed of the piston in high-pressure engines, which reaches 500 feet per minute, would add greatly to the efficacy and speed of this propeller.

In applying steam power to give motion to the paddle wheels and screw, it is necessary to convert the reciprocating motion of the piston into a continuous rotatory motion, which is effected by means of the crank, and in direct-acting engines

Plate II.



velocity is obtained by shortening the crank and the stroke of the piston and thereby increasing the number of strokes and revolutions of the engine. But this shortening of the crank greatly increases the friction and consequent loss of power. If the velocity of the piston could be increased to any required rate it would simply be necessary to connect the piston-rod to the shaft of this propeller, and the whole force of the steam would thus be available for direct propulsion, without parallel motion, levers, or other gearing, and an immense saving would be effected in the weight of the engines. In the *Terrible* steam frigate of 1847 tons, and 800 horse-power, the contract weight of the engines was 212 tons, and the weight of the paddle wheels 44 tons.

There seems to me no sufficient reason why the present speed of the piston should not be greatly increased. If a great object is to be gained by an increased speed, a corresponding effort must be made to surmount the difficulties that may interpose, and there is no doubt, I think, that a greatly increased speed could be obtained by lengthening the cylinder, and using high pressure steam.

Until this is accomplished it will be necessary to multiply the velocity of the piston by means of levers, and to prevent any loss of power from the reciprocating motion of the levers, by means of the equalising air cylinder. The science of hydraulics in its application to propulsion is confessedly difficult to be understood, and no theory will be accepted as the present time that is not amply supported by experimental proof. Experiments properly conducted for testing the capablities of this propeller, and its comparative value, would involve a large expenditure of time and money, and I have therefore no experimental proof at present to offer in support of its alleged advantages. But the principle on which it is constructed is so obvious, and its construction is so simple, that careful theoretical deductions with regard to its practical application are not likely to deviate much from the truth.

In the position where the propeller is intended to work, the water will have a slight retrograde motion, partly induced by the action of the propeller, and partly by the collapse of the water in the wake of the ship when in motion.

At the commencement of each stroke, the floats will rapidly expand until they come to rest on the shoulder attached to the shaft, in which position the floats will be at right angles to the course of the ship, and will present the whole of their surface in the most favourable position for acting against the water, and will so continue to the end of the stroke. However rapid the movement of the propeller, a certain time is required for the floats to get into this position, and therefore, especially if the floats have a large surface, there will be a slip, amounting probably in extreme cases to one foot, which it will be, perhaps, impossible to prevent; at the end of the stroke, when the action of the propeller in the water ceases, the floats will be rapidly feathered by the forward movement of the ship. In the act of feathering there will be a certain resistance and loss of power from the sudden lateral displacement of the water, caused by the rotation of the floats upon their axes.

The projecting neck of each float will be thrown forward, but, as it is very narrow, and may be made still more so than shown in the model, this portion of the float will offer no resistance of any consequence.

The only loss of power, therefore, will arise from the backward and lateral movement of the body of the float.

The backward movement of the float will rapidly take place at the end of the stroke, and before the commencement of the return stroke, the fixed extremity of the float being carried forward by the motion of the ship, while the free extremity is left behind.

The float therefore will turn on its centre, the water being displaced partly forward and partly backward. A certain loss of power must result from this displacement which it would be difficult to estimate, but from the rapidity of the movement, and the extremity of the float being left unrestrained in its motion, it is difficult to see how the resistance could be great.

During the lateral movement of the float the return stroke of the piston will begin to operate on it, and the act of feathering will be completed in a gradual manner during its rapid forward movement. The extent therefore of the lateral movement of the float will not correctly express the amount of displacement or the actual loss of power, the float being drawn obliquely rather than forced laterally into its position parallel with the shaft. Thus the actual lateral displacement of the water will be practically very much modified and diminished.

In theory, therefore, the loss of power in feathering the floats would appear to be very small, and in a length of stroke of ten feet could scarcely exceed one foot, and supposing one tenth part of the stroke of the propeller to be ineffectual for